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# TIME AND LEVEL OF PHOSPHATE AND POTASH FERTILIZER IN RELATION TO YIELD AND DAMAGE SUSCEPTIBILITY OF POTATOES, 1979

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SUMMARY

There was a significant overall yield response to potash up to 600 kg/ha, the highest rate examined. This was observed where the potash was applied wholly or in part in the autumn or 6 weeks before planting. Potash applied immediately before seedbed cultivations appeared to be unavailable in a relatively dry season. Internal blackspot bruising was significantly reduced by treatments favouring a high uptake of potash. Applied phosphate had no effect on yield or tuber quality.

## OBJECT

Earlier work by the Norfolk Agricultural Station at Morley had shown benefits to both yield and tuber quality where high rates of potash fertilizer were used. However, in some situations high rates of muriate of potash in the seedbed delayed emergence.

This trial examines various times of application in an attempt to solve this problem. At the same time response to phosphate is being investigated.

## TREATMENTS

All combinations of the following treatments applied to the main crop variety Desiree in a fully factorial trial with 2 replicates:-

(1) Level of Phosphate (kg/ha)

a) Nil
b) 150
c) 300

(2) Level of Potash (kg/ha)

a) Nil
b) 200
c) 400
d) 600

(3) Time of Fertilizer Application

a) Ploughed down in previous autumn
b) Applied to the surface-approximately 6 weeks before planting
c) Applied to the surface immediately before seedbed preparation
d) Split - all phosphate applied to seedbed as in (c)
   - 100 kg potash applied to seedbed, the balance having been ploughed down in the previous autumn

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METHOD

The autumn fertilizer treatments were applied to the stubble of the preceding vining pea crop on 2 October, 1978, and the whole area was ploughed on 10-11 November. The early spring fertilizer treatments were applied on 28 February. Nitrogen was applied overall as a broadcast dressing of 210 kg/ha and Kieserite was applied overall at 345 kg/ha on 12 April. Seedbed fertilizer was applied to the plough furrows on 17 April and worked into the soil by cultivations on 20 April.

Phosphate was applied as triple superphosphate (47% $P_2O_5$) and potash as muriate of potash (60% $K_2O$).

The trial was planted using a hand assisted Robot planter on 91 cm rows on 20 April, using seed which was unsprouted but had 'eyes' well open.

A single precautionary blight spray using a metalaxyl/mancozeb mixture (Fubol) was applied on 4 July.

During the growing season observations were made on crop emergence and vigour. The trial was harvested on 8 October following haulm destruction by sulphuric acid on 17 September. Blight was not seen in the trial.

RESULTS

Crop Emergence - Plant counts made during emergence over the period 28 May to 18 June showed that although the early emergence was affected by treatment, differences in later emergence were small. Table 1 gives some indication of the scale of the effects on the number of days to 50% emergence.

Table 1 Days to 50% crop emergence

| Time of application | Level of potash (kg/ha) 0 | 200 | 400 | 600 | Mean |
|---|---|---|---|---|---|
| | | (±0.18) | | | (±0.09) |
| Autumn | 40.4 | 40.5 | 40.9 | 41.1 | 40.7 |
| Pre-planting | 40.7 | 40.3 | 40.2 | 40.0 | 40.3 |
| Planting | 40.0 | 39.9 | 39.8 | 40.0 | 39.9 |
| Split K | 39.8 | 40.2 | 40.5 | 41.3 | 40.5 |
| | | (±0.09) | | | |
| Mean | 40.2 | 40.2 | 40.4 | 40.6 | |

S.E. per plot (47 d.f.) = ±0.44 or 1.1% of G.M.

Table 2 Plant population 18 June - 000's/ha

| Time of application | Level of potash (kg/ha) 0 | 200 | 400 | 600 | Mean |
|---|---|---|---|---|---|
| | | ($\pm$0.90) | | | ($\pm$0.45) |
| Autumn | 31.7 | 31.0 | 30.7 | 30.1 | 30.9 |
| Pre-planting | 31.1 | 30.3 | 30.5 | 31.6 | 30.9 |
| Planting | 31.5 | 29.8 | 30.3 | 31.6 | 30.8 |
| Split K | 31.5 | 30.5 | 30.8 | 30.1 | 30.7 |
| | | ($\pm$0.45) | | | |
| Mean | 31.5 | 30.4 | 30.6 | 30.8 | |

S.E. per plot (47 d.f.) = $\pm$2.21 or 7.2% of G.M.

The final plant populations counted on 18 June showed there was an average of 30,800/ha with little difference between treatments.

## Crop Growth

Soil samples taken at 0-30 cm depth before fertilizers were applied showed phosphate to be at index 3 and potash at index 1. Adequate reserves of lime and magnesium were recorded.

During crop emergence there was adequate rainfall to maintain soil moisture in the ridge for early crop growth. Rainfall was below average in July and haulm growth appeared to be restricted.

| | Rainfall (mm) 1979 | 10 yr. av. |
|---|---|---|
| 21-30 April | 20.2 | 14.2 |
| 1-31 May | 80.5 | 47.6 |
| 1-30 June | 38.8 | 40.8 |
| 1-31 July | 12.7 | 48.5 |
| 1-31 August | 66.8 | 52.8 |

The main effects of treatment on haulm growth are given in table 3.

Table 3 Crop growth assessments

| Treatment | % Ground Cover 27 June | % Ground Cover 20 July | Haulm Colour Score* 20 July | % Haulm Senescence 4 Sept. |
|---|---|---|---|---|
| Time of application | (±1.27) | (±1.22) | (±0.10) | (±1.72) |
| Autumn | 39.6 | 72.3 | 5.0 | 43.8 |
| Pre-planting | 59.8 | 77.7 | 5.2 | 55.2 |
| Planting | 50.8 | 64.8 | 5.6 | 68.9 |
| Split K | 47.3 | 74.2 | 5.1 | 46.9 |
| Level of potash(kg/ha) | (±1.27) | (±1.22) | (±0.10) | (±1.72) |
| 0 | 51.0 | 64.0 | 5.6 | 67.8 |
| 200 | 52.1 | 71.7 | 5.3 | 53.3 |
| 400 | 50.2 | 75.2 | 5.0 | 48.9 |
| 600 | 44.2 | 78.1 | 4.9 | 44.7 |
| Level of phosphate (kg/ha) | (±1.10) | (±1.06) | (±0.09) | (±1.49) |
| 0 | 46.6 | 69.7 | 5.2 | 52.9 |
| 150 | 50.3 | 73.6 | 5.2 | 53.5 |
| 300 | 51.2 | 73.4 | 5.2 | 54.6 |
| S.E. Per plot (47 d.f.) | ±6.22 | ±5.97 | ±0.50 | ±8.41 |
| or as % G.M. | 12.6 | 8.3 | 9.7 | 15.7 |

*Colour Score: 1 = Very pale yellow/green; 10 = Dark blue/green

Initial haulm growth was obviously retarded where increasing levels of potash were ploughed down in the autumn. This effect was not observed where the fertilizers were applied to the seedbed at or before planting in the spring and suggests that haulm growth was influenced by the adverse effects of potash concentration on the initial root development. Later assessments revealed that this growth check had been overcome and that generally increasing potash levels were contributing towards improved haulm development. However, application of potash to the seedbed at planting did not produce any response in haulm growth in late July, indicating that at this stage it was not available because of dry conditions in the ridge.

Some applied phosphate was beneficial to haulm growth but in general the response was small.

Further evidence that the late applied K was less available in the dry ridge comes from the haulm colour observations. Low potash uptake is associated with a dark leaf colour and where potash was applied at planting the haulm was darker than that with other methods or times of application.

Haulm senescence in early September was generally decreased by increasing K level, especially where all or some of the fertilizer was ploughed down in the previous autumn. Again, late application of potash at planting which resulted in advanced senescence with a lack of response to increasing potash levels further confirms that this potash was not available to the crop in these conditions.

Phosphate appeared to have little effect on haulm senescence.

Leaf Analysis

Leaf samples taken on 24 July were analysed for P and K content. As in the previous year phosphate treatment did not appear to influence % P in the leaf. Table 4 gives a summary of the effects of potash treatment on % K in the leaf dry matter.

Table 4 Leaf analysis - % K

| Time of application | Level of potash (kg/ha) 0 | 200 | 400 | 600 | Mean |
|---|---|---|---|---|---|
| Autumn | 1.72 | 2.59 | 3.07 | 3.61 | 2.75 |
| Pre-planting | 1.52 | 2.01 | 2.32 | 2.40 | 2.06 |
| Planting | 1.60 | 1.54 | 1.50 | 1.55 | 1.55 |
| Split K | 1.54 | 2.09 | 2.77 | 3.40 | 2.45 |
| Mean | 1.59 | 2.06 | 2.42 | 2.74 | |

In general potash uptake in the leaves increased with increasing levels of potash fertilizer applied to the crop but as expected, late K application to the seedbed did not increase potash uptake.

Yield and Tuber Quality

After harvest the trial produce was riddled into the following size fractions: less than 40 mm, 40-60 mm, 60-80 mm, and over 80 mm. At the same time samples of tubers were taken for assessment of specific gravity, % dry matter, % phosphate and % potash. The results are presented in tables 5 and 6.

Table 5 Ware Yield 40-80 mm - t/ha

| Treatment | Level of potash(kg/ha) 0 | 200 | 400 | 600 | Level of phosphate(kg/ha) 0 | 150 | 300 | Mean |
|---|---|---|---|---|---|---|---|---|
| Time of application | (±1.03) | | | | (±0.89) | | | (±0.52) |
| Autumn | 27.3 | 33.0 | 35.4 | 35.4 | 34.2 | 32.5 | 31.6 | 32.8 |
| Pre-planting | 25.6 | 32.6 | 34.7 | 37.3 | 32.1 | 33.0 | 32.6 | 32.5 |
| Planting | 26.0 | 26.2 | 25.5 | 28.3 | 26.3 | 27.7 | 25.6 | 26.5 |
| Split K | 26.5 | 32.9 | 35.2 | 36.5 | 31.6 | 33.0 | 33.7 | 32.8 |
| Level of potash(kg/ha) | | | | | (±0.89) | | | (±0.52) |
| 0 | | | | | 26.6 | 26.8 | 25.7 | 26.4 |
| 200 | | | | | 30.4 | 31.4 | 31.8 | 31.2 |
| 400 | | | | | 33.2 | 33.1 | 31.8 | 32.7 |
| 600 | | | | | 34.0 | 35.0 | 34.2 | 34.4 |
| | (±0.52) | | | | (±0.45) | | | |
| Mean | 26.4 | 31.2 | 32.7 | 34.4 | 31.0 | 31.6 | 30.9 | |

S.E. per plot (47 d.f.) = ±2.53 or 8.1% of G.M.

There was a marked difference in yield response to fertilizers where the application was made at planting compared with applications made earlier. There appeared to be little benefit from this late dressing while potash ploughed down in the autumn or broadcast on the plough several weeks before planting gave substantial yield increases, especially to the first increment of 200 kg/ha potash.

There was generally no response to phosphate. (The apparent yield reduction seen in the table of interaction between phosphate level and time of application results from means derived from potash treatments).

Table 6 Tuber Quality

| Treatment | Specific Gravity | % Dry Matter | % P (in D.M.) | % K (in D.M.) | % Tubers with blackspot |
|---|---|---|---|---|---|
| Time of application | (±0.00042) | | | | (±1.45) |
| Autumn | 1.0957 | 23.3 | 0.19 | 2.13 | 18.7 |
| Pre-planting | 1.0996 | 23.9 | 0.20 | 1.81 | 27.5 |
| Planting | 1.1033 | 24.8 | 0.21 | 1.43 | 46.9 |
| Split K | 1.0975 | 23.2 | 0.21 | 2.06 | 21.4 |
| Level of potash(kg/ha) | (±0.00042) | | | | (±1.45) |
| 0 | 1.1028 | 24.4 | 0.21 | 1.51 | 45.7 |
| 200 | 1.1011 | 24.3 | 0.20 | 1.71 | 27.8 |
| 400 | 1.0978 | 23.8 | 0.20 | 1.97 | 23.0 |
| 600 | 1.0944 | 22.7 | 0.20 | 2.23 | 18.0 |
| Level of phosphate(kg/ha) | (±0.00036) | | | | (±1.25) |
| 0 | 1.0987 | 23.6 | 0.19 | 1.86 | 28.3 |
| 150 | 1.0989 | 23.7 | 0.20 | 1.86 | 28.2 |
| 300 | 1.0994 | 24.0 | 0.21 | 1.85 | 29.4 |
| S.E. per plot (47 d.f.) | ±0.00204 | | | | ±7.09 |
| or as % G.M. | 0.2 | | | | 24.8 |

The most notable effects on tuber quality are the level of potash applied and the availability of that potash through time of application. Uptake of potassium generally relates directly to the level applied except in the case of the late seedbed treatment. Also there was a strong relationship between level of potash applied and both specific gravity and % dry matter, both values falling with increasing potash.

Internal blackspot bruising was assessed after a period of cool storage. As in previous years there was a significant reduction in bruising with increasing potash.

In general phosphate treatments had very little effect on tuber quality.

Provisional Summary of Yields and Bruising Assessments 1976-79 (excluding 1977)

| Treatment | Ware Yield (t/ha) | % tubers with blackspot |
|---|---|---|
| Time of application | (±0.60) | (±1.25) |
| Autumn | 31.0 | 20.2 |
| Pre-planting | 31.1 | 22.4 |
| Planting | 28.8 | 27.8 |
| Split K | 31.1 | 20.7 |
| Level of potash (kg/ha) | (±0.60) | (±1.25) |
| 0 | 24.0 | 32.4 |
| 200 | 30.9 | 23.8 |
| 400 | 32.8 | 19.5 |
| 600 | 34.1 | 15.4 |
| Level of phosphate (kg/ha) | (±0.52) | (±1.08) |
| 0 | 30.2 | 22.8 |
| 150 | 30.5 | 22.9 |
| 300 | 30.8 | 22.6 |

The lack of response to seedbed applied K in the relatively dry summer of 1979 has reduced the overall mean yields for this timing treatment so that the value of early K applications, especially where all or part was autumn applied and ploughed down, is shown to be of considerable importance to yield and tuber quality. As in a previous trial series on similar soils (K index 1; P index 2 to 3) ware yields increased and bruising was reduced with each additional increment of potash. Phosphate had little effect in the context of the high level of soil phosphate on this site.

Since the cost of 200 kg/ha of potash is around £27, each increment was justified by the yield alone. In addition, there was an improvement in quality, and the extra potash would contribute to soil reserves, thus reducing or eliminating the need for applications for subsequent cereal crops.

This trial series has demonstrated that for soils with good phosphate reserves but inadequate potash, yields and quality can be maintained where phosphate and potash fertilizers are applied in the autumn and ploughed down compared with their application to the plough furrow several weeks before planting.

Where soil phosphate reserves are low it is likely that autumn applied phosphate may not be satisfactory, therefore some form of spring application of P would be more appropriate in these situations.

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